-Polymer membrane reactors for enhanced hydrocarbon conversion and upgrading, S. Vasileiadis and Zoe Ziaka, Invention Disclosure Document #414880, marked 3/6/1997.

TECHNICAL FIELD

This invention relates to new process and reactor designs including permeable reactors (permreactors) and permeators for the hydrocarbon steam reforming, hydrocarbon carbon dioxide reforming, combined hydrocarbon steam and carbon dioxide reforming, alcohol steam reforming, water gas shift, paraffin dehydrogenation, methanol synthesis, and combination of these conversion reactions for production of valuable fuels and chemicals. It also relates to the utilization of the end reaction products such as pure hydrogen, hydrogen and carbon monoxide, hydrogen and carbon dioxide, and mixtures of these species, into specific applications such as fuel cells, gas turbines, gas engines and synthesis reactors.

BACKGROUND OF THE INVENTION

This current application is continuation in part of the application # 08/595040 filed 1/31/1996, Pat. 6,099,312.

This current invention describes new and improved process and reactor designs which involve permeable reactors (permreactors) and permeators for the hydrocarbon steam reforming, hydrocarbon carbon dioxide reforming, combined hydrocarbon steam and carbon dioxide reforming, alcohol steam reforming, the water gas shift reaction, dehydrogenation reactions of hydrocarbons, such as dehydrogenation of alkanes (i.e., paraffins) to alkenes, and combination of these previous reactions.

The reactions and heats of reactions that are referred to and utilized within the embodiments of the invention are well known and are listed below:

$CH_4 + H_2O = CO + 3H_2$ (ΔH°_{298}=206.1kJ/mol), methane-steam reforming (1)

$CH_4 + CO_2 = 2CO + 2H_2$ (ΔH°_{298}=247.3kJ/mol), methane-CO_2 reforming (2)

$CO + H_2O = CO_2 + H_2$ (ΔH°_{298}=-41.15kJ/mol), water gas shift (3)

$C_nH_{2n+2}=C_nH_{2n} + H_2$ (endothermic dehydrogenation reactions, heat of reaction varies depending on the type of feedstock processed in the reactor, e.g., ethane, propane, butane, pentane) (4)

$CO + 2H_2 = CH_3OH$ (ΔH°_{298}=-128.2kJ/mol), methanol synthesis (5)

$CO_2 + 3H_2 = CH_3OH + H_2O$ (ΔH°_{298}=-49.5kJ/mol), methanol synthesis (6)

$CH_3OH + H_2O = CO_2 + 3H_2$ (ΔH°_{298}= 49.5kJ/mol), methanol-steam reforming (7)